

# Space

## Physics II: Modern Physics

Tuesday and Wednesday, April 5 and 6, 2022

College of the Atlantic

Do this worksheet in parallel with the spacetime worksheet. Work in pairs if you wish. There is nothing to hand in.

1. What *is* distance? Your answer should be a sentence, not a formula.
2. What is a formula for the distance  $\Delta d$  between two points in a particular coordinate system? We will view this formula as fundamental. We'll use it as a starting point to for spatial geometry.
3. In a particular coordinate system, let point A be at the origin and let point B have the coordinates  $x = 3, y = 4$ .
  - (a) What is the distance between A and B?
  - (b) In another coordinate system<sup>1</sup>, suppose that  $x = 0$ . In this coordinate system, what is  $y$ ?
  - (c) In another coordinate system suppose that  $y = 0$ . In this coordinate system, what is  $x$ ?
  - (d) In another coordinate system suppose that  $y = -3$ . In this coordinate system, what is  $x$ ?
  - (e) In another coordinate system, suppose that  $y = 2$ . In this coordinate system, what is  $x$ ?

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<sup>1</sup>In all of these other coordinate systems, assume that A is still at the origin, but that the axes are rotated so that the point B now has different  $x$  and  $y$  values.

4. Illustrate this state of affairs on a graph.

- (a) Draw a coordinate system (set of axes) on which B has the coordinates  $x = 3, y = 4$ .
- (b) On these axes, draw all the other  $x, y$  values that you found in the previous problem.

(c) The set of all possible  $x, y$  values for B makes what shape? Why? Answer both mathematically and physically.

5. In another coordinate system the point B has a value of  $x = 6$ . In this coordinate system, what is  $y$ ?

6. Out of all the possible other coordinate systems, in what coordinate system is  $y$  the largest? Physically or geometrically, how would you describe this coordinate system?

7. If we know  $d$  and either  $x$  or  $y$ , we can use the distance equation to figure out whichever of  $x$  and  $y$  we don't know. You've done this repeatedly in the problems above. But sometimes we might know the distance  $d$  and an angle  $\theta$ . This scenario is illustrated below.

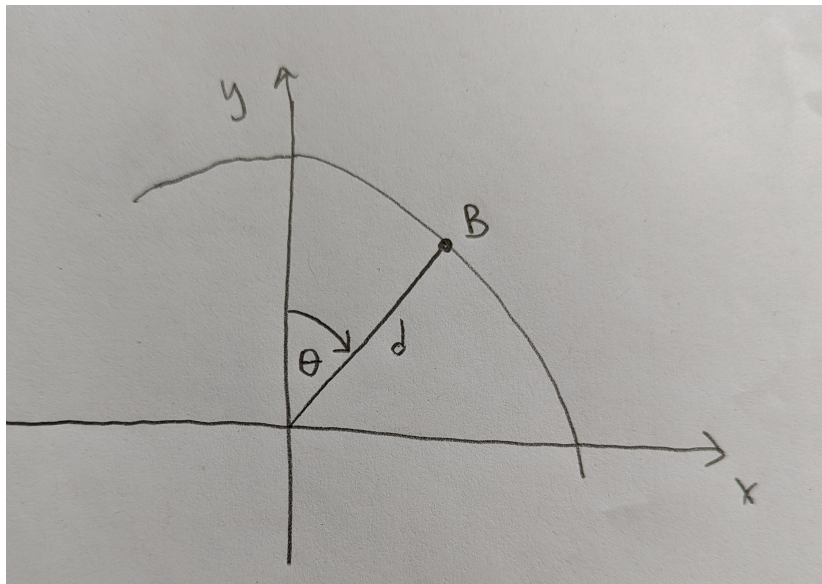


Figure 1: A circle of radius  $d$ . What are the  $x$  and  $y$  coordinates of point B?

- (a) Write down formulas for  $x$  and  $y$  in terms of  $\theta$  and  $d$ .
- (b) What *are* sine and cosine? How are they defined?? Hmm..... Well, let's just take your answers to the previous problems as the definition of sine and cosine. It would be nice to have a formula for sin and cosine. But your calculator has buttons for these functions, so that's almost as good as a formula. Use your calculator to:
- Find  $x$  and  $y$  if  $\theta = 65$  degrees and  $d = 4$ .
  - Find  $\theta$  if  $x = 3$  and  $y = 4$ .
- (c) Use your answers to Question 7a and the distance formula to show that:
- $$\cos^2(\theta) + \sin^2(\theta) = 1 . \tag{1}$$
- (d) What *is* an angle, anyway? What is the "correct" way to define an angle?
- (e) What is  $\sin(0)$ ? What is  $\cos(0)$ ?